Overview
ATV - Automated Transport Vehicle
sEMG - Surface Electromyography
OpenCV - Open Source Computer Vision

Key Words - Automation, robotics, disability assistance, infrared user tracking

People with disabilities need a device to more easily transport their possessions. The goal of this project is to create an ATV which can independently carry cargo, reducing bodily strain on the user. The ATV will be able to navigate through difficult terrain and follow a user via an onboard infrared camera. It will have an alternate control scheme, which takes input from filtered sEMG signals obtained from the user. An onboard computer will perform biosignal analysis, and allow for motor control of the robot using these processed signals.

Intellectual Merit
This Small Business Innovation Research Phase I project implements qualities from various disciplines, including computer science, mechanical engineering, biomedical engineering, and systems engineering. The first technical challenge will be the construction of the ATV. In order to fulfill size, weight, portability and mobility requirements, the ATV will be stabilized by a Rocker-Bogie mechanism similar to that of the Mars rovers. This will provide more freedom of movement, and let the ATV drive over simple curbs and small steps. The cargo compartment will remain relatively flat with the use of a differential gear system. User tracking will be accomplished using an infrared camera attached to an onboard computer. The infrared camera is capable of providing a stream of pictures at a rate of nine pictures a second. These pictures are each 80 by 60 pixels, and contain enough data encoded in infrared intensity values to track a user. The ATV's computerized control system will analyze these infrared images while simultaneously providing navigational instructions to the ATV's motorized wheels. OpenCV will be the initial framework used to parse image data, and it's multi-platform availability can provide flexibility for this project should a platform/operating system change become necessary. The biosignal acquisition will implement circuit-level filtering and amplification. Signals will pass through an Analog-to-Digital converter. The signals will be processed and converted to motor commands which will then travel wirelessly to the ATV's onboard computer. The computer will override automated control when receiving biosignal inputs, and allow for motor control using sEMG sensors.

Broader Impact

Multiple members participating in this project have undergone major surgeries, and suffered mobility restrictions as a result. A need exists to carry large amounts of cargo without straining one's arms or legs. Other devices exist which provide some combination of user tracking, multi-terrain capabilities, ease-of-use, and simplicity. However, no device currently exists which fulfills all of the previous qualifications. This research project will create such a device, and provide a method of cargo carrying for handicapped individuals.

Overview

Key Words - Automation, robotics, disability assistance, infrared user tracking

The goal of this project is to create an automated transport vehicle (ATV) which can independently carry cargo, thereby reducing bodily strain on the user. A reduction of bodily strain would greatly help people with disabilities, since this system will easily transport their heavy possessions. The ATV will be able to navigate through difficult terrain and follow a user via an onboard camera.

Intellectual Merit

This Small Business Innovation Research Phase I project implements qualities from various disciplines, including computer science, mechanical engineering, biomedical engineering, and systems engineering. The first technical challenge will be the construction of the ATV. In order to fulfill size, weight, portability and mobility requirements, the ATV will be stabilized by a Rocker-Bogie mechanism similar to that used by the Mars rovers. This will provide more freedom of movement, and let the ATV drive over curbs and small steps. The cargo compartment will remain relatively flat with the use of a differential gear system. This ATV leverages existing technologies, but combines them in a compact profile and with a simple-to-use interface that has not been seen before in other devices. User tracking will be accomplished with an infrared camera, and the produced stream of infrared pictures will be analyzed before providing navigational instructions to the ATV's motorized wheels. Infrared imagery has historically been reserved for military technologies and challenges, providing a means for weapon systems to locate targets in varied environments. Infrared's applicability in target acquisition and tracking is undeniable, but its usage in consumer-grade computer vision systems is surprisingly limited. This project hopes to fill in that void. The open-source toolset, OpenCV, will be used to parse image data, and its multi-platform availability can provide flexibility for this project should a platform/operating system change become necessary.

Broader Impact

While the original intention of this project was to help disabled individuals carry heavy cargo without strain on the arms and legs, other use cases for this project exist. Elderly individuals and individuals with temporary handicaps would benefit greatly from this technology. Similar systems are in development to increase productivity at retail stores, malls, other marketplaces. An automated system that carries both heavy items and a large quantity of items around a store would benefit both customers and employees. This project expands upon extensive research done in the field of computer vision, user-tracking and robotics. However, there is little previous research in computer vision applications using infrared imagery, and this project hopes to build a foundation for this field of study.

Elevator Pitch

Times when one is required to carry large items, heavy items, or just too many items are frequent. A system that eliminates such a tedious chore would have many potential use cases. The elderly, handicapped, temporarily disabled, and customers and employees of large retail stores can reduce incredible amounts of bodily strain by letting an automated system transport heavy loads. Creating a system that can both carry heavy objects and automate its movement is the ultimate end goal for this project. Using technologies typically reserved for military applications, this automated transport vehicle (ATV) will be able to follow a user through various terrain, over obstacles like curbs and stairs, and keep its cargo area safe and flat. An onboard computer system will be able to identify and follow a designated target within the field of view of the attached Forward Looking Infrared (FLIR) camera.

Similar technologies exist or are in development. Systems like the Leo by SITA perform customer check-ins and have pioneered automated baggage reception and transportation at airports. Starship Technologies has created a robot that operates on a programmed schedule, can traverse crowded areas, and automate the laborious process of picking up groceries and other necessities. Our project's goal lies somewhere between these two systems--the ATV will help with deliveries, can navigate through urban, suburban, and rural terrain, and carry heavy loads. However, no previous projects have provided a reliable method for user identification and tracking. They have been operating in previously known and mapped out environments, while this system will always be actively analyzing its environment, and not relying on existing data. Implementing techniques from the realms of computer science, mechanical engineering, biomedical engineering, and systems engineering, this project will present numerous challenges. In order to fulfill size, weight, portability and mobility requirements, the ATV will be stabilized by a Rocker-Bogie mechanism similar to that used by the Mars rovers. A differential gear system will stabilize the cargo compartment, ensuring that the user's belongings remain unscathed while being transported. This project will begin a discussion about image analysis and computer vision using FLIR cameras, and will add to the extensive list of projects accomplished using the open-source vision software, OpenCV. The ATV has great effort-conserving potential, and knowledge gained from its development can be used by future computer vision systems primarily concerned with the identification of humans.